

Claims:

1 1. A structure formed with a template defining a pattern having nanoscale features
2 that may be positioned on a substrate, the template including a resist layer having openings
3 formed therein, where the template is configured to accommodate the controlled assembly of
4 nanoscale objects.

1 2. A structure according to Claim 1, wherein the template is configured to aid in the
2 positioning of nanoscale objects about the template and proximal to the substrate.

1 3. A structure according to Claim 1, wherein the template is configured to be
2 removed from the substrate without removing the nanoscale objects.

1 4. A structure according to Claim 1, wherein the template is configured to
2 accommodate the growth of nanoscale objects through the openings.

1 5. A structure according to Claim 4, wherein the template is configured to
2 accommodate the growth of a nanoscale wire outward from the surface of the substrate through
3 the openings.

1 6. A structure according to Claim 4, wherein the template is configured to
2 accommodate the growth of a nanoscale object in a predetermined orientation with respect to the
3 surface of the substrate through the openings of the template.

1 7. A structure according to Claim 4, wherein the template serves as a guide to
2 accommodate the growth of a nanoscale object in a predetermined orientation with respect to the
3 surface of the substrate.

1 8. A structure according to Claim 1, wherein the template is configured with
2 openings to receive a deposition of nanoscale objects.

1 9. A structure according to Claim 1, wherein the nanoscale objects are a film
2 configured to coalesce when heated.

1 10. A structure according to Claim 1, wherein the nanoscale objects are deposited on
2 the template by a method chosen from at least one of the group consisting of, Langmuir-
3 Blodgett, self-assembly, evaporation, electrodeposition, electroless deposition, dipping, spraying,
4 physical bonding, and chemical bonding.

1 11. A structure according to Claim 1, wherein the nanoscale objects are chosen from
2 at least one of the group consisting of molecular film, electroplated film, nanowires,
3 nanoparticles, nanorods, nanotubes, fullerenes, viral particles, polynucleic acid, polypeptides,
4 proteins, DNA, quantities of polynucleic acids, and liquids.

1 12. A structure according to Claim 1, wherein at least one of the openings are of a
2 shape chosen from a group including cubic, elongated, equiaxed, triangular, and cylindrical.

1 13. A structure according to Claim 1, wherein the size and shape of the openings are
2 predetermined.
3

4 14. A structure according to Claim 13, wherein the size and shape of at least one of
5 the openings are chosen to accommodate a particular size and shape of a nanoscale object.

1 15. A structure according to Claim 13, wherein the size and shape of at least one of
2 the openings are chosen so as to exclude nanoscale objects of a particular size range.

1 16. A structure according to Claim 13, wherein the size and shape of at least one of
2 the openings are chosen to accommodate a plurality of nanoscale objects of a particular size in
3 one opening, and to accommodate nanoscale objects of another size in another opening.

1 17. A structure according to Claim 13, wherein the size and shape of at least one of
2 the openings are chosen to accommodate a specific maximum number of nanoscale objects.

1 18. A structure according to Claim 13, wherein the size, shape, and position of at least
2 one of the openings are chosen to accommodate a plurality of nanoscale objects substantially
3 arranged in a predetermined orientation.

1 19. A structure according to Claim 13, wherein the size and shape of at least one of
2 the openings are chosen to accommodate nanoscale objects in a predetermined range of
3 orientation coordinates.

1 20. A structure according to Claim 13, wherein the size, shape, and position of at least
2 one of the openings are chosen to accommodate nanoscale objects in a predetermined
3 arrangement, such as for example a square arrangement, other than a naturally occurring
4 arrangement, such as a triangular close-packed arrangement.

1 21. A structure according to Claim 13, wherein the size and shape of at least one of
2 the openings are chosen to accommodate nanoscale objects of different sizes within separate
3 levels within an opening..

1 22. A structure according to Claim 13, further comprising a multiple level nanoscale
2 opening having a smaller opening within a larger opening and configured to accommodate
3 different sized nanoscale objects within the different sized openings.

1 23. A structure according to Claim 1, wherein the structure is positioned on a
2 substrate having components located thereon, the template including a resist layer having
3 openings formed therein and configured to position nanoscale objects to contact and
4 conductively expose the components on a surface of the template opposite the substrate.

1 24. A structure according to Claim 1, wherein the structure is positioned on a
2 substrate having components located thereon, the template including a resist layer having
3 openings formed therein and configured to position nanoscale objects to contact and
4 conductively expose the components to other components located on a surface of the template
5 opposite the substrate.

1 25. A structure according to Claim 1, wherein the structure is positioned on a
2 substrate having conductive wires located thereon, the template including a resist layer having
3 through-vias formed therein to aid in the positioning of nanoscale objects in a manner to contact
4 and conductively expose conductive wires located on a surface of the template opposite the
5 substrate.

1 26. A method of fabricating ordered patterns of nanoscale objects on a substrate
2 surface comprising:

3 applying a layer to a substrate surface;
4 stamping an imprint mold onto the layer; and
5 releasing the imprint mold to expose a template having a template surface formed into the
6 imprint resist layer and having nanoscale openings formed therein to receive nanoscale objects.

1 27. A method according to Claim 26, further comprising selectively removing
2 residual layer material from the substrate surface to expose a template having a template surface
3 formed into the imprint resist layer and having nanoscale openings formed therein to receive
4 nanoscale objects.

1 28. A method according to Claim 26, further comprising:
2 applying a first set of nanoscale objects to the template surface in a manner to cause one
3 or more of the nanoscale objects to be proximal to the substrate surface through the nanoscale
4 openings.

1 29. A method according to Claim 28, wherein at least one of the first set of
2 nanoscale objects remains outside of the openings and wherein at least one of the objects
3 contacts the substrate surface.

1 30. A method according to Claim 29, further comprising:
2 removing the nanoscale objects that remain outside of the openings.

1 31. A method according to Claim 30, further comprising:
2 removing the nanoscale objects that remain outside of the openings with a chemical
3 wash.

1 32. A method according to Claim 26, wherein the nanoscale openings are ordered in a
2 pattern with respect to at least one of the group consisting of size, shape, orientation, pattern, and
3 position.

1 33. A method according to Claim 26, further comprising selectively removing a
2 residual portion of the resist layer from the substrate surface.

1 34. A method according to Claim 28, further comprising removing the template from
2 the substrate surface.

1 35. A method according to Claim 28, further comprising initiating a linear or non-
2 linear growth of the one or more nanoscale objects.

1 36. A method according to Claim 28, wherein the first set of nanoscale objects is
2 comprised of DNA, polynucleic acid, polypeptides, or a layer of chemistry.

1 37. A method according to Claim 36, wherein the DNA, polynucleic acid,
2 polypeptides, or a layer of chemistry are further used in chemical sensing applications or as
3 scaffolding material to construct biomolecular architectures.

1 38. A method according to Claim 28, wherein the first set of nanoscale objects are
2 each configured to accommodate molecular attachment

1 39. A method according to Claim 28, further comprising depositing a second set of
2 nanoscale objects to a surface of the template.

1 40. A method according to Claim 39, wherein the first set of nanoscale objects is of a
2 different size than the second set of nanoscale objects.

1 41. A method according to Claim 26, wherein the stamping is performed by a step
2 and flash lithographic method.

1 42. A method according to Claim 28, wherein the nanoscale openings are configured
2 in a predetermined pattern.

1 43. A method according to Claim 42, wherein the pattern is symmetrical.

1 44. A method according to Claim 42, wherein the pattern is nonsymmetrical.

1 45. A method according to Claim 42, wherein the pattern contains at least one
2 symmetrical pattern.

1 46. A method according to Claim 42, wherein the pattern contains at least one
2 nonsymmetrical pattern.

1 47. A method according to Claim 42, wherein the pattern contains at least one
2 periodic pattern.

1 48. A method according to Claim 42, wherein the pattern contains at least one
2 nonperiodic pattern.

1 49. A method according to Claim 26, wherein the openings are of one or more
2 predetermined sizes.

1 50. A method according to Claim 26, wherein the openings are of one or more
2 predetermined shapes.

1 51. A method according to Claim 26, wherein the openings are positioned in one or
2 more predetermined orientations.

1 52. A system for making a structure having an ordered pattern of nanoscale features
2 on a substrate surface, comprising:

3 a template with the ordered pattern of nanoscale features on a substrate surface;
4 and

5 means for applying nanoscale objects about the template in a manner
6 to cause the nanoscale objects to contact or be proximal to the substrate surface.

1 53. A system according to Claim 52, further comprising:

2 means for creating the template includes means for creating a template utilizing a
3 mold.

1 54. A system according to Claim 53, wherein the means for creating a template
2 utilizing a mold includes means for creating a mold by carving a wafer in an inverse of the
3 ordered pattern.

1 55. A system according to Claim 53, wherein the means for creating a template
2 utilizing a mold includes means for creating a mold by carving a wafer in a shape
3 complementary to the ordered pattern.

1 56. A system according to Claim 54, wherein the wafer is composed of one of the
2 group consisting of metal, silicon, plastic, glass, and quartz.

1 57. A system according to Claim 55, wherein the means for creating a template
2 utilizing a mold includes means for creating a mold from a wafer utilizing an electron beam.

1 58. A system according to Claim 55, wherein the means for creating a template
2 includes means for creating a template using thermal imprint lithography.

1 59. A system according to Claim 52, wherein the nanoscale features provide vias
2 through the template.

1 60. A system according to Claim 52, further comprising conductive means located on
2 the substrate, and through-vias within the template configured to accommodate nanoscale
3 particles that can conductively expose the conductive means on an opposite side of the template.

1 61. A system according to Claim 52, wherein further comprising conductive means
2 located on the substrate, and through-vias within the template configured to accommodate
3 nanoscale particles that can conductively expose the conductive means to other conductive
4 means located on an opposite side of the template.

1 62. A system according to Claim 59, wherein the vias connect wires located on
2 opposite sides of the template when nanoscale particles are deposited within the vias.

1 63. A system according to Claim 52, further comprising means for applying a second
2 set of nanoscale objects about the template in a manner to cause the second set of nanoscale
3 objects to contact or be proximal to the first set of nanoscale objects.

1 64. A system according to Claim 59 wherein the vias connect electrical devices.

1 65. A system according to Claim 52, wherein the nanoscale objects provide electrical
2 function including those chosen from the group including simple electrical connection,
3 rectification, Coulomb blockade, switching, amplification, memory, and impedance.

1 66. A system according to Claim 65, wherein the electrical function is provided by
2 the nanoscale objects in conjunction with any elements to which they are connected or proximal.

1 67. A method of using a template to fabricate ordered patterns having nanoscale
2 features on a substrate, said method comprising the steps of:

3 applying an imprint resist layer to the substrate;
4 stamping an imprint mold onto the imprint resist layer;
5 releasing the imprint mold;
6 selectively removing residual resist material from the substrate to expose a template
7 having a template surface formed into the imprint resist layer and having openings formed
8 therein; and
9 applying nanoscale objects to the template in a manner to cause the nanoscale objects to
10 be proximal to the substrate through the openings.

1 68. A method according to Claim 67, wherein the nanoscale objects contact the
2 substrate and operate as ball bearings with respect to aligning a second template relative to the
3 template.

1 69. A method of using a mold to fabricate a template of an ordered pattern having
2 nanoscale features, said method comprising the steps of:

3 applying an imprint resist layer onto a substrate;
4 using the mold to stamp the ordered pattern into the resist layer;
5 removing the mold; and
6 removing residual resist material from the substrate to expose the template of the ordered
7 pattern, where the template is configured for assembly of nano scale objects.

1 70. A method of positioning at least one nanoscale object, comprising:
2 providing a template having at least one nanoscale opening, the opening being created by
3 use of an imprint lithography process; and
4 applying nanoscale objects to the template in a manner so that at least one of the
5 nanoscale objects at least partially enters the opening.

1 71. The method of claim 70, further comprising:
2 after the applying step is performed, removing the template.

1 72. The method of claim 70, further comprising:
2 prior to providing the template, creating the opening in the template using the imprint
3 lithography process.